WISDOT
FLYASH STABILIZATION

JUNE 2006

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Wisconsin DOT

AGENDA

GENERAL OVERVIEW

WISDOT USE AND EXPERIENCES

DESIGN CONSIDERATIONS

CONSTRUCTION OPERATIONS

ASSESSMENT AND ACTIONS

General Overview

The process of mixing class “C” fly ash with in -place soils to improve strength and stability

Class “C” fly ash has cementitious properties similar to portland cement

When mixed with soil and water, a reaction occurs binding the material into a stable matrix

Mixing occurs to a depth of about 12 inches

The mixture is compacted at near optimum moisture to a specified percent of maximum density

The compacted mixture is cured for a specified length of time

Strength gains in the mixture are significant – often 4 to 8 times that of the untreated soil

Strength gains are permanent – the character of the soil has been changed

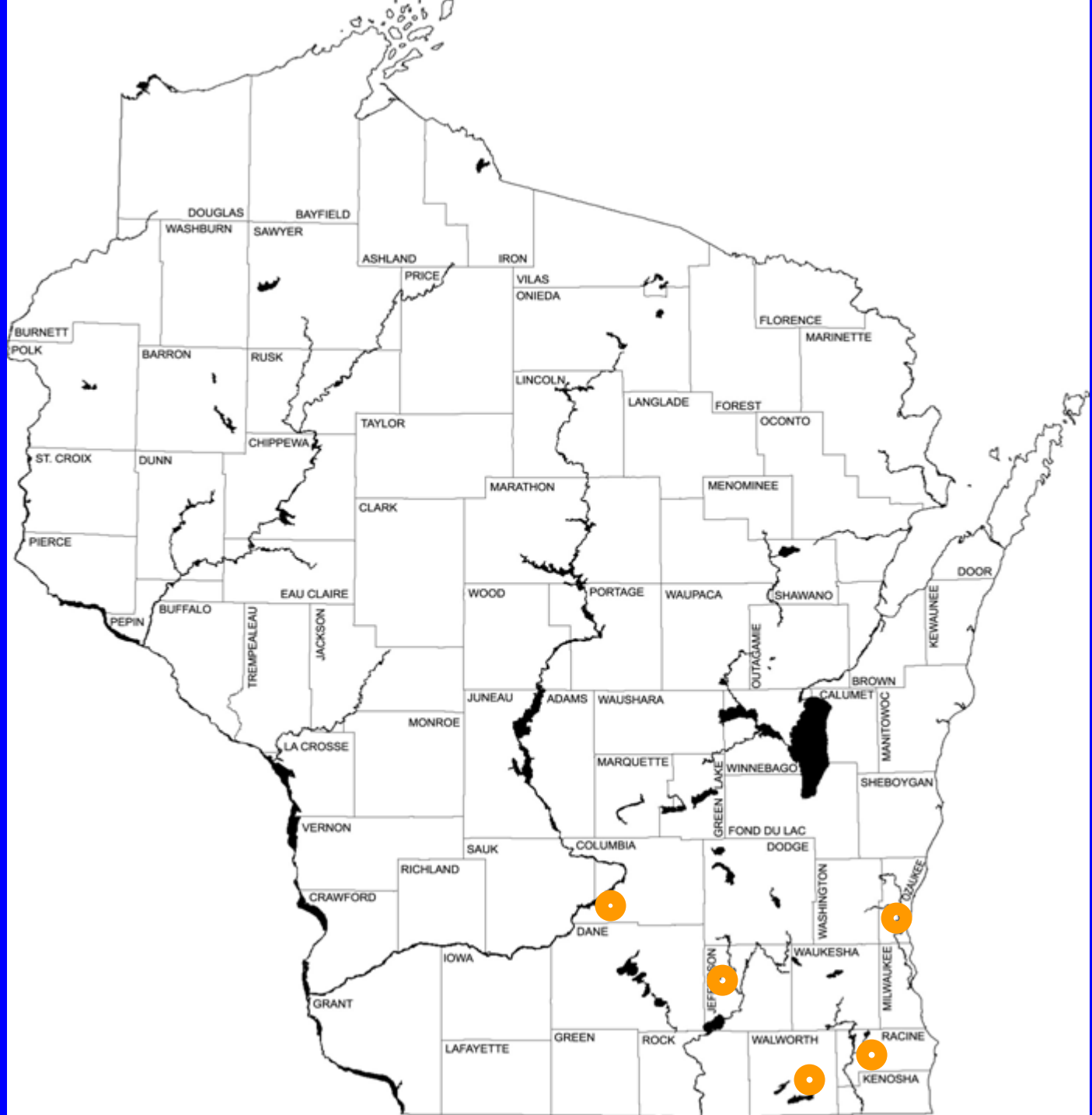
WisDOT Use & Experience

Fly ash stabilization has been used on 5 projects over the last 6 years

All in the southern part of the state

All have been in silty or clayey silt soils

Several of these have occurred as contract changes


DOUGLAS
BAYFIELD
WASHBURN
SAWYER
ASHLAND
IRON
PRICE
VILAS
ONEIDA
FLORENCE
MARINETTE
BURNETT
POLK
BARRON
RUSK
LINCOLN
LANGLADE
FOREST
OCONTO
TAYLOR
CHIPPEWA
ST. CROIX
DUNN
MARATHON
MENOMINEE
CLARK
PIERCE
DOOR
EAU CLAIRE
WOOD
PORTAGE
WAUPACA
SHAWANO
KEWAUNEE
PEPIN
BUFFALO
TREMPEALEAU
JACKSON
OUTAGAMIE
BROWN
JUNEAU
ADAMS
WAUSHARA
CALUMET
MANITOWOC
MONROE
LA CROSSE
MARQUETTE
WINNEBAGO
SHEBOYGAN
GREEN LAKE
VERNON
FOND DU LAC
SAUK
COLUMBIA
DODGE
RICHLAND
OZAUKEE
CRAWFORD
WASHINGTON
DANE
IOWA
WAUKESHA
JEFFERSON
MILWAUKEE
GRANT
GREEN
ROCK
WALWORTH
RACINE
LAFAYETTE
KENOSHA

Goal on each project has been to improve a weak subgrade

Part of a WisDOT initiative to use select materials to improve subgrades

Primary function is to provide a stable platform for base placement and paving operations

Secondary functions are to improve long term pavement performance and to reduce pavement costs

WisDOT experience with fly ash stabilized subgrades has been positive

Stabilization produces a very firm and stable platform for the pavement structure

Have experienced no problems with frost heaves, localized subgrade failures, or general lack of pavement support

Cost is comparable or less than alternate methods - currently about $4.00 to $4.50 per yd. Sq.

STH 32 first full scale project – 3 miles, four lanes

Contractor proposed to replace 20” sand subbase with fly ash/lime stabilization of existing subgrade

Based on test results, WisDOT requested that only fly ash be used

Contractor (Edgerton Construction) agreed

Excellent results and a saving of $350,000

WisDOT applications have been limited to subgrade soil stabilization

Fly ash can also be used to stabilize crushed aggregate bases and recycled asphaltic pavement

WisDOT has considering fly ash stabilization of base material and old pavement, but has not used this application on a project

Design Considerations

Treatment most effective in silt and clay soils

A thorough examination of subgrade soils is important

Soils with significant cobbles are problematic

Distance to fly ash sources needs to be considered

The application rate must be determined and included in the contract

WisDOT design process

Obtain representative samples of subgrade soil

Conduct laboratory testing

- **Natural moisture**
- **Grain size analysis**
- **Atterberg limits**
- **Optimum moisture and maximum density by AASHTO T-99**
- **Unconfined compressive and/or CBR strength at 95% of max. density and optimum moisture**

Mix fly ash with the soil in increasing amounts

usually ranging from 8% to 16%

Determine optimum moisture and maximum density for each incremental mixture

Determine unconfined compressive strength and/or CBR for each increment at optimum moisture and 95% of maximum density

Plot results as strength vs. % fly ash

Determine the optimum % of fly ash and the design level from the peak of the curve

Include this value in the special provisions for the contract as an application rate of lbs. per yd. sq.

WisDOT does have special provisions that are available for use

Submitted by: Bruce Pfister	Date 6/25/03

STATION	Bags from stations 15+175 and 15+345 combined for testing					
OFFSET						
SAMPLE TYPE	As rec'd	Pass #4	10% fly ash	12% fly ash	14% fly ash	
% PASSING (AASHTO T-11, T-27 & T-248)						
3"						
2"						
1 1/2"	100					
1"	99					
3/4"	98					
1/2"	96					
3/8"	95					
# 4	94	100				
# 10	91	98				
# 40	86	91				
# 100	74	78				
# 200	68.3 ✓	73.0 ✓				
LIQUID LIMIT (AASHTO T-89)	37					
PLASTICITY INDEX (AASHTO T-90)	21					
UNIFIED CLASSIFICATION (ASTM D 2487)	CL					
AASHTO CLASSIFICATION (AASHTO M-145)	A-6 (12) ✓					
FAA CLASSIFICATION						
LOSS ON IGNITION, % (AASHTO T-267)						
MOISTURE CONTENT, % (AASHTO T-265)						
COMPACTION TEST						
AASHTO T -99, METHOD		A	A	A	A	
OPTIMUM MOISTURE, %		15.4	13.2	15.1	15.2	
MAXIMUM DENSITY, PCF		112.3 ✓	113.5 ✓	113.6 ✓	113.6 ✓	
CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST (AASHTO T-224)						
OPTIMUM MOISTURE, %	14.6					
MAXIMUM DENSITY, PCF	114.5 ✓					
UNCONFINED COMPRESSION TEST (AASHTO T-208)						
MOISTURE CONTENT, %		15.1	13.6	15.2	15.1	
UNIT WEIGHT, PCF		106.1	107.6	108.0	108.0	
% MAXIMUM DENSITY		94.5	94.8	95.1	95.1	
UNCONFINED COMPRESSION, PSF		2435 ✓	8204 ✓	9616 ✓	8443 ✓	

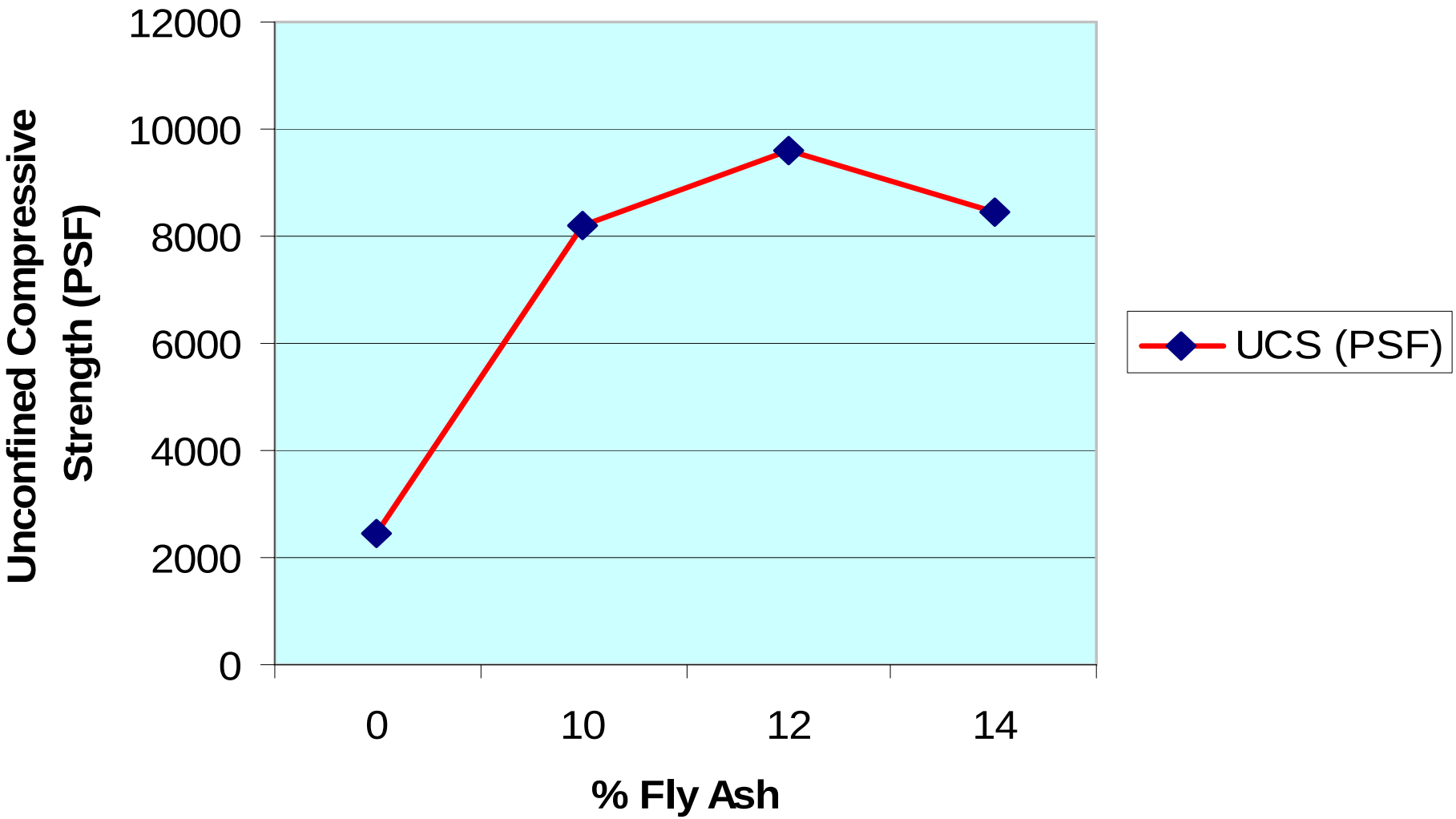
Remarks

T-224 calculations base upon an assumed BSG of 2.600
Fly ash source is Columbia
Stabilized QU's tested at a strain rate of 0.5%/minute after a 7 day curing period

DISTRIBUTION: Geotechnical Unit
District

By WRK

Unconfined Compressive Strength Vs % Fly Ash Content



Construction Operations

Subgrade is brought to finished grade level

Normal construction procedures apply

Fly ash is spread evenly over the subgrade

Specialized spreading equipment is used

Dust control is important


KENWO


AMSTOR


SPEED
LIMIT
55

Mixing is done with a pulvomixer

Mixing with a motor grader is not acceptable

Mixing depth is 12 inches

Water is added by the pulvomixer to maintain specified water levels

Mixing must start within 1 hour from time of placement


WR2500
Wirtgen


WATER
WR 2500
Wirtgen
175016

Compaction starts immediately after mixing

Must be completed within 2 hours

Required compact level is 95% of maximum density at optimum moisture +/- 2%

If compaction not complete within the specified time, the section must be reprocessed

Testing is done with a nuclear gauge


213 PDB-2
123033


WATER
ROUGH ROAD
45
MPH


KENWORTH

Subgrade trimmed and finished immediately after compaction is completed.

Compacted subgrade must be cured for 24 hours without traffic

Must be kept moist for 72 hours or covered with moist base course

Base course can be placed after 24 hours

Problem areas can be treated to a greater depth

Normal application depth of 12 inches is usually sufficient

Reprocessed areas require additional fly ash


KENWORTH

Fly Ash Stabilization is measured by the square yard completed and accepted

Includes placing the fly ash and all mixing, compacting, shaping, and curing operations

Fly Ash, Furnished is measured by the ton and paid under a separate bid item

Total cost is estimated at about $4.00 to $4.50 per sq. yd.

Assessment and Actions

WisDOT has experienced excellent results with fly ash subgrade stabilization

Increasing acceptance by designers, but some Regions have not used fly ash stabilization

Department will continue activities to acquaint in-house and consultant staff with fly ash stabilization

WisDOT focus and actions:

Will continue to look for projects with the right conditions for fly ash stabilization

Will work with the Regions to improve and refine fly ash stabilization construction specifications

Will continue to monitor and report on existing installations

Expectation is that WisDOT will expand its use fly ash stabilization

Questions???